

# **ADAPTING TO SEA-LEVEL RISE: WHERE NORTH CAROLINA STANDS**

by

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## ABSTRACT

In 2007, the Intergovernmental Panel on Climate Change released their 4<sup>th</sup> assessment report which provided indisputable evidence that the world climate is warming, leading to changes in sea-level caused by two factors: melting land ice and thermal expansion of the oceans. This report conservatively estimated between 0.18 and 0.59 meters of global mean sea-level rise by 2100. Although sea level rise is a global issue, the specific effects and magnitude felt by different coastal communities are unique. Sea-level at a specific location, relative sea-level, is not influenced solely by GMSL but also by factors such as variations in global land ice which effects the gravitational field of the Earth, local vertical land movements such as sediment compaction and tectonics, as well as changes in coastal currents and local water temperature. The National Oceanic & Atmospheric Administration has identified North Carolina as highly vulnerable to effects of SLR because of its “high wave exposure, low-relief coastal slope, and abundance of barrier islands.” In addition, the Atlantic coast of the United States is experiencing subsidence, a sinking of the Earth’s surface caused by either natural or human-induced causes.

In 2010, the North Carolina Coastal Resources Commission’s Science Panel on Coastal Hazards completed the *North Carolina Sea-Level Rise Assessment Report*, requested by the Coastal Resources Commission to inform sea-level rise policy in the state. The report included a recommendation that North Carolina use of a one meter of rise benchmark for planning purposes. Almost two-and-a-half years later, North Carolina received national and international ridicule for its legislative decision that prohibits factoring a rate of sea-level rise into coastal planning until, at the earliest, July 1, 2016.

This masters project will examine how the current law passed despite the recommendation of the Coastal Resources Commission’s Science Panel and will elucidate the future courses of action that the state may execute after the release of a five-year follow-up to the *North Carolina Sea-Level Rise Assessment Report* in March 2015.

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## **LIST OF ACRONYMS**

CAMA – Coastal Area Management Act

CZMA – Coastal Zone Management Act

GMSL – Global mean sea-level

IPCC – Intergovernmental Panel on Climate Change

NCDCM – North Carolina Division of Coastal Management

NCDENR – North Carolina Department of Environment and Natural Resources

NCSLRAR – North Carolina Sea-Level Rise Assessment Report

NOAA – National Oceanic and Atmospheric Administration

RSL – Relative sea-level

SLR – Sea-level rise

## CHAPTER I: INTRODUCTION

In 2007, the Intergovernmental Panel on Climate Change (IPCC) released their 4<sup>th</sup> assessment report which provided indisputable evidence that the world climate is warming, leading to sea-level change caused by two factors: melting land ice and thermal expansion of the oceans. Over the last 50 years, global sea-level rise (SLR) has occurred at a rate of 1.8 mm/year, and the past 20 years have seen an increase in that rate to 3.1 mm/year,<sup>1</sup> almost a 60% rate increase. The IPCC estimates that by the end of the 21<sup>st</sup> century SLR will increase to a rate of 3.8 mm/year.<sup>2</sup> The 4<sup>th</sup> IPCC report predicted a rise in global mean sea-level (GMSL) between 0.18-0.59 meters of by 2100.<sup>3</sup> This SLR estimate is thought to be conservative because the IPCC did not factor melting Greenland and Antarctic ice sheets into their estimates due to its contribution to SLR holding uncertainty.

Not only are the 2007 estimates conservative, IPCC did not address regional estimates of SLR, which may be different from global estimates.<sup>4</sup> IPCC's predictions indicate that SLR will become an increasingly important concern for the management of coastal communities worldwide. Although sea level rise is a global issue, the specific effects and magnitude felt by different coastal communities are unique. Sea-level at a specific location, relative sea-level (RSL), is not influenced solely by GMSL but also by factors such as variations in global land ice which effects the gravitational field of the Earth, local vertical land movements such as sediment compaction and tectonics,<sup>5</sup> as well as changes in coastal currents and local water temperature.<sup>6</sup>

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<sup>1</sup> *IPCC 4th Assessment Report: Climate Change 2007*. Intergovernmental Panel on Climate Change (IPCC).

<sup>2</sup> *Ibid*

<sup>3</sup> *Ibid*

<sup>4</sup> *North Carolina Sea-Level Rise Assessment Report*. NC Coastal Resources Commission's Science Panel on Coastal Hazards. March 2010. Pg. 7.

<sup>5</sup> *IPCC 5th Assessment Report: Climate Change 2013, The Physical Science Basis*. Intergovernmental Panel on Climate Change (IPCC). Chapter 13, Pg. 1148.

<sup>6</sup> *North Carolina Sea-Level Rise Assessment Report*. Pg. 7.

Because SLR is not globally uniform in its rate or magnitude, decisions made to address threats associated with SLR necessitate customization to each community's situation and needs.<sup>7</sup>

The National Oceanic & Atmospheric Administration (NOAA) has identified North Carolina as highly vulnerable to effects of SLR because of its “high wave exposure, low-relief coastal slope, and abundance of barrier islands.”<sup>8</sup> In addition, the Atlantic coast of the United States is experiencing subsidence,<sup>9</sup> a sinking of the Earth's surface caused by either natural or human-induced causes.<sup>10</sup> Natural causes would include occurrences such as sinking of land attributable to tectonic shifts. Human-induced causes are often related to extraction of below-ground resources, such as water or petroleum, through mining or compaction of sediments.<sup>11</sup>

In response to an amplified demand for water to accommodate a growing population, North Carolina has been increasing the amount of groundwater it removes from coastal aquifers in the past 15 years. In some types of porous sediment, such as the sediment found in North Carolina's coastal plain, groundwater is one of the forces that hold up the ground. When the water is removed compaction of sediment can occur, causing subsidence.<sup>12</sup>

The removal of large amounts of groundwater brings up many currently unanswered questions including how it will affect subsidence rates and freshwater discharge into streams, estuaries, and wetlands as well as concerns of saltwater intrusion, which is already being experienced in parts of South Carolina. During a 33 year period from 1935 to 1968, a subsidence

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<sup>7</sup> “NOAA Sentinel Site Program.” National Oceanic & Atmospheric Administration. <<http://oceanservice.noaa.gov/sentinelsites/>>. Accessed 30 Oct 2013.

<sup>8</sup> “North Carolina Sentinel Site Cooperative.” National Oceanic & Atmospheric Administration. <<http://oceanservice.noaa.gov/sentinelsites/north-carolina.html>>. Accessed 30 Oct 2013.

<sup>9</sup> Rona, P.A. “Subsidence of Atlantic Continental Margins.” *Tectonophysics* 22 (1974) 283-299.

<sup>10</sup> “Subsidence.” *Encyclopedia Britannica*. 2014. Online.

<sup>11</sup> “Subsidence.” *Encyclopedia Britannica*. 2014. Online.

<sup>12</sup> “Land Subsidence.” The USGS Water Science School. <<http://water.usgs.gov/edu/earthgwlandsubside.html>>. Accessed 28 Mar 2014.

of almost 0.18 meters was documented in North Carolina's central Coastal Plain.<sup>13</sup> This subsidence was documented before the recent increase in groundwater extraction but illustrates the magnitude of potential subsidence that could occur and the enormity of impact that subsidence could have on RSL in an area. North Carolina is experiencing subsidence for various reasons and this is one of the many mechanisms that figures into RSL and local SLR in North Carolina. Because of local characteristics like subsidence, North Carolina could experience a rise in RSL even if GMSL was not increasing. The combination of an increase in GMSL and North Carolina's specific challenges make concerns related to SLR especially pertinent for this coastal state.

In 2012, North Carolina received national and international ridicule for its legislative policy on SLR, House Bill 819, which declared:

*The General Assembly does not intend to mandate the development of sea-level policy or the definition of rates of sea-level change for regulatory purposes...No rule, policy, or planning guideline that defines a rate of sea-level change for regulatory purposes shall be adopted...*<sup>14</sup>

This legislation occurred *after* the completion of the *North Carolina Sea-Level Rise Assessment Report* (NCSLRAR), which was commissioned specifically for the purpose of informing SLR legislation in North Carolina and which recommended adoption of one meter of SLR by 2100 for planning purposes.

### **Problems Associated with Sea-Level Rise**

The obvious concern related to SLR is loss of land from permanent inundation, but that is not the sole issue with which the citizens of North Carolina need to be concerned regarding increased sea-levels. Other consequences of SLR are raised water tables, saltwater intrusion, and

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<sup>13</sup> "Groundwater Availability of the Atlantic Coastal Plain Aquifers of North and South Carolina." USGS Office of Groundwater, Groundwater Resources Program. <<http://sc.water.usgs.gov/projects/gwavailability/>>. Accessed 28 Mar 2014.

<sup>14</sup> "House Bill 819v6: Section 2.(a)." General Assembly of North Carolina, Session 2011, Session Law 2012-202.



the potential for increased erosion rates. Although these are not issues that can be regulated, the public policy system will have to adapt and these are issues that may warrant planning initiatives and should be kept in mind when considering potential legislation.<sup>15</sup>

Raised water tables and saltwater intrusion have implications for the coastal plain's farming community as well as wildlife. Both impacts can affect the types of plants and water-sensitive animals that can live in an area and can cause die-offs for plants and habitat shifts for non-sessile animals. Salt-water intrusion also has potential to affect underground aquifers in the coastal plain, a resource that is currently a supply of drinking water in the state. Salt water contamination of aquifers may not have an immediate effect on drinking water supplies, but would eventually require the state to consider alternatives for its drinking water supply.

The Southeast United States has been identified as an area where increased sea-level may correspond to an increased risk of erosion.<sup>16</sup> Erosion is already a problem in North Carolina, especially throughout the state's unique barrier island system. Although erosion is not uniform along the North Carolina coast, and some areas are actually experiencing accretion, beaches in the state can lose several feet of sand per year under current circumstances.<sup>17</sup>

Long-term erosion impacts were made obvious by the need to move the Cape Hatteras Light Station in 1999. Upon completion in 1870, the Cape Hatteras Light Station stood 1,500 feet from the ocean. Hatteras Island experiences sound-ward migration caused by over-wash from ocean to sound during storm surges. By 1970 the distance from the lighthouse to the water was reduced to a meager 120 feet. Since 1930 a total of four groins were installed in an effort to

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<sup>15</sup> Allenby, J. "Determining the socio-economic and environmental impacts of sea-level rise to Bogue Banks, NC." Duke University Masters Project 2011. Pg. 15.

<sup>16</sup> Karl, T.R., J. M. Melillo, T.C. Peterson, et al. "Global Climate Change Impacts in the United States." Cambridge University Press, New York, New York. 2009. Pg. 10

<sup>17</sup> "Coastal Hazard & Storm Information: What You Should Know About Erosion and Oceanfront Development." NC Department of Environment and Natural Resources, Division of Coastal Management. <<http://www.nccoastalmanagement.net/hazards/erosion.htm>>. Accessed 30 Mar 2014.

reduce the ocean-side erosion and protect the lighthouse, but the structures were still threatened. Eventually the decision was made to preserve the historic structures by moving them to a location almost 3,000 feet southwest of their original locations.<sup>18</sup> Although erosion is a natural occurrence, especially on barrier islands, increasing sea-levels can amplify natural erosion rates causing it to be a more imminent threat.

Increased erosion rates, amplification of storm surges because surges will reach higher on the land, and changing environmental factors through raised water tables and saltwater intrusion are all plausible consequences that need to be taken into account when considering the effects of SLR on the state.

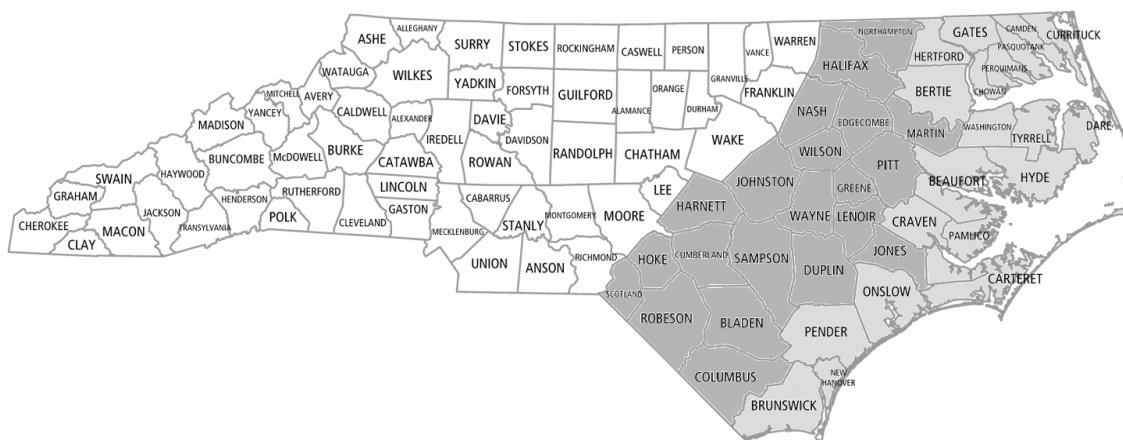
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<sup>18</sup> “Moving the Cape Hatteras Lighthouse.” National Park Service.  
<<http://www.nps.gov/caha/historyculture/movingthelighthouse.htm>>. Accessed 30 Mar 2014.

## CHAPTER II: TOTAL ECOLOGY

When fully analyzing a policy issue and making recommendations for future management initiatives, one needs to address its total ecology in addition to possible resolutions. The total ecology of a situation consists of three separate ecologies: biophysical, human, and institutional. The biophysical ecology is defined by a set of non-human biophysical characteristics of a system, such as a politically or environmentally defined boundary. The human ecology consists of both the humans and human behaviors that affect, or are affected by, the biophysical ecology of a situation. The institutional ecology is comprised of the governance institutions (entities as well as rules/regulations) that affect the actions of the humans and behaviors included in the human ecology. These three separate ecological components all need to be considered because, at its core, policy decision-making is value-based and is intended to balance the physical environment, what the humans affected care about, and what the current legislative framework allows in regard to the issue.<sup>19</sup>

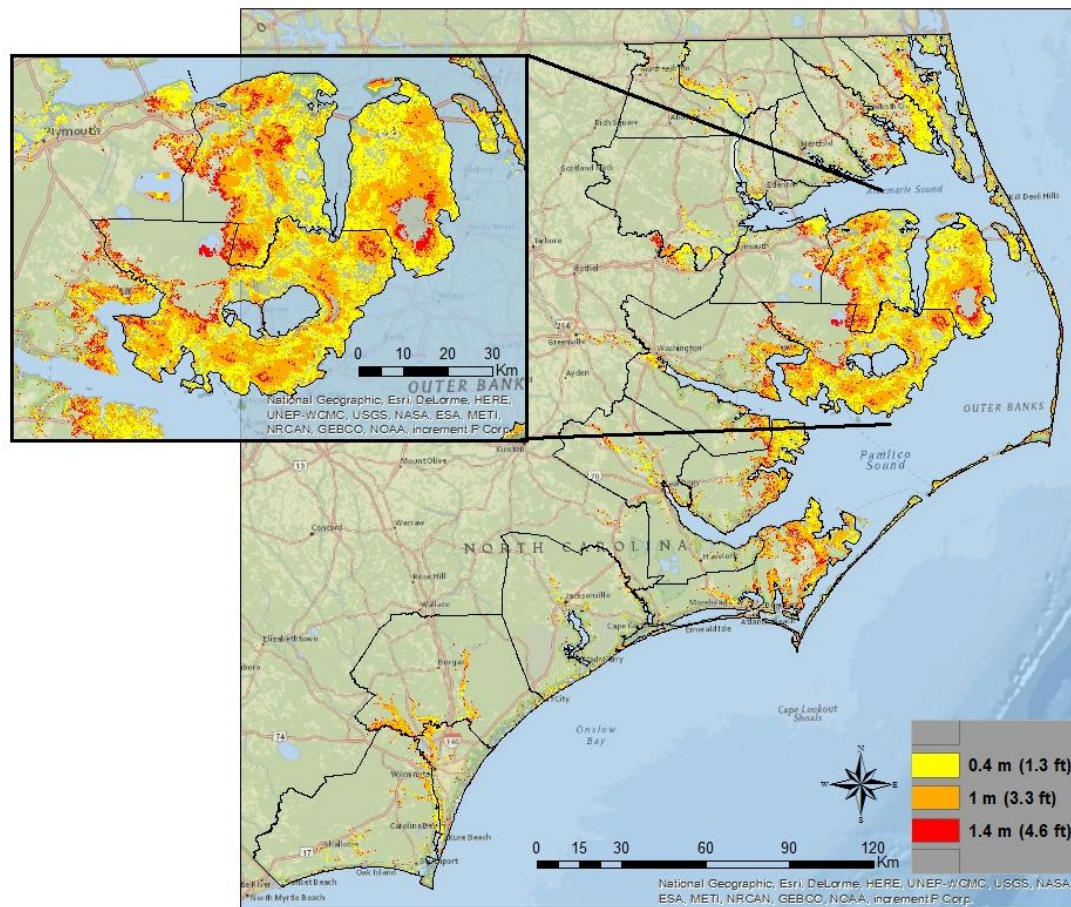
### Biophysical



*Figure 1: Map of North Carolina's 20 coastal counties (light grey) and counties in the coastal plain (light and dark grey).*

<sup>19</sup> Orbach, M. (2009) "A Brief Essay on the Nature of Environmental Policy." (Unpublished). Duke University Marine Laboratory, Beaufort, NC.

The biophysical ecology of this situation involves both politically and environmentally defined boundaries. Political boundaries include the 20 coastal counties in North Carolina<sup>20</sup> (Figure 1) as well as the boundaries of any incorporated town or city within those counties. It may also include the counties and towns in the coastal plain (Figure 1) that may experience various effects related to SLR such as rising water tables and saltwater intrusion and certainly includes counties that are projected to experience direct effect of SLR even at low projections, such as Martin and Pitt (Figure 2).



*Figure 2.* Map of potential inundation for 0.4, 1.0, and 1.4 meters of SLR in North Carolina (projected rise levels based on NCSLRAR). Coastal counties are outlined. Inset is of Tyrell, Dare, and Hyde counties. Elevation data from NCDOT (cell size = 80 foot, [https://connect.ncdot.gov/resources/gis/Pages/Cont-Elev\\_v2.aspx](https://connect.ncdot.gov/resources/gis/Pages/Cont-Elev_v2.aspx)), projection is NAD83, base map is National Geographic (ESRI). Map by K. Shipley.

<sup>20</sup> "House Bill 819v6: Section 1."

Environmentally defined areas are those that are predicted to be inundated due to SLR as well as the nearshore waters of the coastal counties. Figure 2 shows predictions of land in the Albemarle-Pamlico Estuary system that could be inundated based on three different magnitudes of SLR but does not include land loss that may be a result of other SLR related effects, such as increased wave intensity. These areas are home to a wide variety of ecosystems including ocean, estuaries, coastal wetlands, and maritime forests. The biophysical ecology of this area also includes an assortment of ecosystem uses with defined boundaries, such as spawning grounds, shell-fishing waters, sea turtle sanctuaries, and military danger zones.<sup>21</sup>

### **Human/Constituent**

The human component of the human ecology includes both the approximate 1 million residents of the 20 coastal North Carolina counties<sup>22</sup> as well as visitors to those counties. Many attractions – the North Carolina Aquarium, beautiful beaches, and year-round festivals and events – attract a substantial number of visitors to the coast yearly. Currently, the North Carolina coastal region boasts 43 million visitors annually.<sup>23</sup> Additionally, organizers of the 27<sup>th</sup> Annual North Carolina Seafood Festival in Morehead City estimated that the three-day festival attracted approximately 200,000 people, many of them not coastal county residents.<sup>24</sup> Human behaviors associated with the biophysical ecology are development (both commercial and residential), agriculture, recreational and commercial fishing, and activities such as water sports.

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<sup>21</sup> “Maps to View and Print.” North Carolina Division of Environment and Natural Resources, Division of Marine Fisheries. <<http://portal.ncdenr.org/web/mf/maps-to-view-and-print>>. Accessed 03 Dec 2013.

<sup>22</sup> “Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2012, 2012 Population Estimates.” US Census Bureau. <<http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk>>. Accessed 25 Oct 2013.

<sup>23</sup> Davis, Braxton. “Executive Secretary Briefing.” North Carolina Coastal Resources Commission. NOAA Auditorium, Beaufort, NC. 4 Nov 2013. Meeting.

<sup>24</sup> Wilcox, Amanda. “Vendors and organizers say NC Seafood Festival as a success.” *News 14 Carolina*. 6 Oct 2013.

## **Institutional**

The institutional ecology of this situation has two parts: the entities that make or enforce the rules and the rules/regulations themselves and can be present at both the federal and state level.

### Federal

Passed in 1972, the Coastal Zone Management Act (CZMA) provided states with guidelines for forming state-specific coastal management plans. A 1992 amendment to the CZMA recognized global warming and resulting SLR as a possible threat to coastal areas that should be addressed by states.<sup>25</sup> This edition of the CZMA declared a national policy of

*Management of coastal development to minimize the loss of life and property caused by improper development in flood-prone, storm surge, geological hazard, and erosion-prone areas and in areas likely to be affected by or vulnerable to sea-level rise, land subsidence, and saltwater intrusion, and by the destruction of natural protective features such as beaches, dunes, wetlands, and barrier islands...*<sup>26</sup>

Although this is the “national policy,” not all states, including North Carolina, chose to prioritize this in their state-specific plans.

### State

The North Carolina General Assembly writes laws and passes legislation that create and distribute the authority and responsibility for making and enforcing rules and regulations. The authority for interpreting the laws relevant to the topic of sea-level rise lies in the hands of the Coastal Resources Commission (hereafter the Commission), and the responsibility for enforcing the regulations lies with the North Carolina Division of Coastal Management (NCDCM). Both

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<sup>25</sup> “Coastal Zone Management Act of 1972.” 16 U.S.C. § 1452 Congressional declaration of policy [Section 302(l)]

<sup>26</sup> Ibid Section 303(2)(B)

the Commission and NCDCM are under the larger umbrella of the North Carolina Department of Environment and Natural Resources (NCDENR).

The Coastal Area Management Act (CAMA) establishes overarching directives for coastal management in North Carolina. Established in 1974 in response to the CZMA,<sup>27</sup> CAMA aimed to establish a cooperative atmosphere of coastal management among the state and the 20 coastal county's local governments. Guidelines, rules, and permits for various types of coastal development activities, including structures and dredge & fill, are established under CAMA. Additionally, CAMA created the Commission and Coastal Resources Advisory Council (CRAC), which provides the Commission with advice and the perspectives of local coastal governments.<sup>28</sup> The Commission is currently composed of 13 members holding seats designated for 10 categorical interests/expertise:

- coastal property owner or experience in land development (2)
- coastal engineering or a marine-related science (2)
- coastal-related business
- local government in the coastal area
- coastal agriculture
- commercial fishing
- sport fishing
- coastal forestry
- wildlife
- general at-large (2)

The Governor is responsible for appointment of nine of the designated seats, while the Speaker of the House of Representatives and President Pro Tempore of the Senate each appoint members to two seats. Commission members serve four-year terms, at the end of which they are

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<sup>27</sup> "CAMA Permits: Federal Consistency." North Carolina Department of Environment and Natural Resources, Division of Coastal Management. <<http://dcm2.enr.state.nc.us/permits/consist.htm>>. Accessed 30 Oct 2013.

<sup>28</sup> "Coastal Resources Advisory Council." North Carolina Department of Environment and Natural Resources, Division of Coastal Management. <<http://dcm2.enr.state.nc.us/CRC/cracmembers.htm>>. Accessed 01 Dec 2013.



either re-appointed or replaced by the current appointing authority.<sup>29</sup> The CRAC is comprised of 20 members serving two-year terms and appointed by the Commission. The only legislative stipulation for appointment is that at least one-half of the members are residents of coastal counties at the beginning of any two-year term.<sup>30</sup>

An important contributor to the institutional ecology of this situation that may go unnoticed is lobbying organizations. A clear example of a lobbying group with an interest in the SLR policy discussions is NC-20, a nonprofit organization that represents the people, businesses, and local governments of the 20 coastal counties, although they are not officially supported by all 20 counties. Founded on an interest in changing stormwater rules, NC-20 most recently has focused their efforts on coastal homeowners insurance and SLR legislation.<sup>31</sup> While these organizations are not governing institutions, they inarguably have interest in coastal issues and hold sway over the General Assembly that makes the rules and, thereby, the rules/regulations themselves. In fact, NC-20 is recognized by many as being instrumental in the passing of the final version of HB819.<sup>32</sup>

In recent years, many changes made to North Carolina legislature will effect SLR discussions or will be effected by the presence or absence of SLR planning guidelines. The most important legislation to date regarding SLR preparation in North Carolina is HB819, mentioned previously, which states that the North Carolina General Assembly will not define a rate of sea-level rise for regulatory purposes.<sup>33</sup> Although HB819 is directly related to SLR legislation, numerous other pieces of recent legislation will affect or be affected by HB819, and some of

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<sup>29</sup> NCGS 113A-104 Article 7. Coastal Area Management Act. <<http://dcm2.enr.state.nc.us/rules/cama.htm>>. Accessed 26 Mar 2014.

<sup>30</sup> NCGS 113A-105.

<sup>31</sup> NC-20: Twenty Counties...One Voice. <<http://www.nc-20.com/>>. Accessed 30 Oct 2013.

<sup>32</sup> Ibid

<sup>33</sup> "House Bill 819v6: Section 2.(a)."



these will likely influence any future decisions by the North Carolina General Assembly related to regulation of SLR preparedness. Three of these are worth closer consideration.

#### *House Bill 1011*

Section 2.1 and Section 2.2: House Bill 1011 changed the Commission from a 15 to a 13 member commission and the CRAC from a 45 member to a 20 member panel.<sup>34</sup> Both entities have an impact on interpreting the rules and regulations that the General Assembly institutes. Limiting the number of members – drastically limiting in the case of the CRAC – means that the range of perspectives represented in those bodies will be reduced. In addition, the Commission seats eliminated in this bill included seats for an expert in marine ecology and a member of a conservation organization, both of which are important perspectives for coastal conservation.

#### *Senate Bill 402*

Section 14.24.(b): Senate Bill 402 removed all but four of the (then) current members of the Commission.<sup>35</sup> This eliminated much first-hand knowledge of the inner-workings of the Commission during a time when many new and/or modified environmental regulations were being passed and need to be interpreted. The Commission postponed its scheduled meeting in September, 2013 due to having so few members, and as of October 15, 2013 only 11 of the 13 seats on the commission were filled.<sup>36</sup> In addition, since the Governor and the General Assembly (currently both represented by Republicans) are responsible for appointing new Commission members, it is possible that a shift in interests and expertise will be evident in the make-up of this body.

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<sup>34</sup> “House Bill 1011: Section 2.1.(a) & 2.2” North Carolina General Assembly, Session 2013.

<sup>35</sup> “Senate Bill 402: Section 14.24.(b).” North Carolina General Assembly, Session 2013, Session Law 2013-360.

<sup>36</sup> “Coastal Resources Commission: Members.” North Carolina Department of Environment and Natural Resources, Division of Coastal Management. < <http://dcm2.enr.state.nc.us/CRC/members.htm> >. Accessed 03 Dec 2013.

An example of this shift may be the appointment of the president of the Homeowners' Association on Figure Eight Island, Frank Gorham, as Chairman of the Commission. Figure Eight Island is one of four towns pursuing permits to construct a terminal groin, a topic that has prompted much controversy along the states coast in recent years. Although Gorham has stated that he will recuse himself from all groin related conversation, many people have questioned the appropriateness of his dual role in this important coastal issue.<sup>37</sup> Also, at the December 2013 Commission meeting, four commission member stated conflicts with a topic to be discussed during the meeting.<sup>38</sup> This amounts to 30% of the commission members stating a conflict on a single issue which may be an indication that the newly appointed commissioners lack variety either in what they bring to the commission or in regional representation.

#### *House Bill 74*

House Bill 74 is a hodge-podge of provisions originally included in other bills that were pulled together in one bill near the end of session. Not all of the sections of HB74 have a direct relation to SLR, but all are significant to coastal management.

Section 10.2(a): Temporarily limits the ability of a city or county to enact ordinances more strict than that of a state or federal regulation enforced by an environmental agency. This section provides that until October 1, 2014, the only way for a city or county to enact a more stringent rule is if the ordinance is approved by a unanimous vote.<sup>39</sup> Although HB819 allows for local governments to define rates of SLR for their own regulation, this legislation makes that very difficult.

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<sup>37</sup> Parker, M. "CRC Chairman is President of Figure Eight HOA." *Star News Online*. 10 Nov 2013

<sup>38</sup> "Call to Order/Roll Call." North Carolina Coastal Resources Commission. Hilton DoubleTree, Atlantic Beach, NC. 11-12 Dec 2013. Meeting.

<sup>39</sup> "House Bill 74: Section 10.2(a)." General Assembly of North Carolina, Session 2013, Session Law 2013-413.

Section 57.(a): Combines the Division of Water Quality and the Division of Water Resources. This will likely entail lay-offs and affect the monitoring and protection of state waters.<sup>40</sup>

### A Changing Institutional Ecology in North Carolina

In recent years, North Carolina has been experiencing reform and in 2013, a significant event occurred in the North Carolina government: the House, Senate, and Governor's office all belonged to a single party for the first time since reconstruction.<sup>41</sup> This has led to a setting that allows for environmental reforms on a level that previously would not have been possible and permits the reversal of environmental protections that the state has offered in the past, making room for coastal developers and businesses to play a larger part.

An example of this is the 2011 passage of Senate Bill 110 which allows for the installation of as many as four terminal groins. North Carolina has a history of protecting its beaches from hard structures, beginning in 1985 when the CRC banned coastal hard structures. The CRC evaluated shoreline modifications from other states and concluded that the potential negative effects on beaches were nearly irreparable. Because of these potential negative effects, the CRC decided to ban construction of such uncertain engineered solutions, including terminal groins.<sup>42</sup> This ban was formally written into state law in 2003 with the passing of HB1028.<sup>43</sup>

In addition to the 2011 bill that instituted the pilot program, Senate Bill 151 (2013) removed many of the barriers facing communities during the permit application process. Some of the most troubling of these is the removal of language requiring that structures be imminently

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<sup>40</sup> "House Bill 74: Section 57.(a)."

<sup>41</sup> "The North Carolina General Assembly: Historic Changes Mark the 2013 Session." Ward and Smith, P.A., 12 Aug 2013. <<http://www.wardandsmith.com/articles/the-north-carolina-general-assembly-historic-changes-marks-the-2013-session>>. Accessed 02 Dec 2013.

<sup>42</sup> "North Carolina Groin Installation: Short Policy Brief."

<sup>43</sup> "House Bill 1028." General Assembly of North Carolina, Session 2003, Session Law 2003-427.

threatened by erosion and that nonstructural mitigation approaches are impractical.<sup>44</sup> Moreover, many of the financial assurances that communities were initially required to provide have been softened or eliminated altogether.<sup>45</sup> Modifications made in this bill make the requirements for terminal groin permits more lenient and is likely to allow construction of groins in areas where they are unnecessary and possibly costly. Furthermore, S151: Section 3.(e).(5). specifies that the required inlet management plan does not have to address SLR. This means that even if North Carolina defines a rate of SLR for regulatory purposes, this bill would have to be modified before SLR was factored into terminal groin permitting processes.

Another indicator of potentially changing times in North Carolina is that the newly appointed Commission Chairman has stated that he “thinks the Coastal Resources Commission can play a small part in helping economic development...along our coast.”<sup>46</sup> Although this is a single quote by a single Commission member, it could be indicative of a shift in priorities of the state and the Commission.

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<sup>44</sup>“Senate Bill 110: Section 1.(e).(1).”

<sup>45</sup> “Senate Bill 151: Section 3.” General Assembly of North Carolina, Session 2013, Session Law 2013-384.

<sup>46</sup> Parker, M. “New CRC chair hopes to aid economic development.” *Star News Online*. 20 Oct 2013.

### CHAPTER III: SEA-LEVEL LEGISLATION IN NORTH CAROLINA

Because of the need for localized customization of sea-level policy and North Carolina's particular vulnerabilities, the North Carolina Division of Coastal Management (NCDCM) requested the Commission's Science Panel on Coastal Hazards provide input on SLR initiatives in the state. In response to the request, the Science Panel released the *North Carolina Sea-Level Rise Assessment Report* (NCSLRAR) in March 2010. In addition to the 13 members of the Science Panel, who range in expertise from coastal geology to engineering, six other professionals contributed to the NCSLRAR at request of the Science Panel.<sup>47</sup>

#### North Carolina Sea-Level Rise Assessment Report

The NCSLRAR focuses on RSL rise on the North Carolina coast and addresses melting ice sheets. The purpose of the report is "to provide North Carolina's planners and policy makers with a scientific assessment of the amount of SLR likely to occur this century" with the result being a recommended amount of rise that should be adopted for *policy development and planning purposes* by North Carolina legislation. The report does not attempt to predict a specific amount or rate of SLR, but to establish a likely range of rise based on current science.<sup>48</sup>

Four recent (2004-2009) studies of RSL in North Carolina were used to inform the NCSLRAR. Three of the studies are based on geologic data over various time scales and the fourth uses instrumental (tide gauge) data over a relatively short time-scale of approximately 70 years.<sup>49</sup> Averaging the tide gauge data for North Carolina shows that it is in accordance with the

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<sup>47</sup> *North Carolina Sea-Level Rise Assessment Report*. Pg. 4-5.

<sup>48</sup> *Ibid* Pg. 3.

<sup>49</sup> *Ibid* Pg. 9-10.

recent portion of the geologic records. Because of this accordance, the Science Panel felt comfortable using the tide gauge data for projections.<sup>50</sup>

### NCSLRAR Conclusions

The Science Panel found that based on models relevant to the local coastline, the possible range of SLR in North Carolina by 2100 is 0.4-1.4 meters (Figure 3).<sup>51</sup> A one meter rise is considered likely not only because it is in between the extremes of predictions, it is also encapsulated in all models considered by the Science Panel.<sup>52</sup> Based on this evidence, the Science Panel recommended that a rise of 1 meter “be adopted as the amount of anticipated rise by 2100, for policy development and planning purposes.”<sup>53</sup> Although the study notes that RSL change is not uniform along the coast of North Carolina, the Science Panel recommended a uniform level of rise for planning at the state level.<sup>54</sup>

### Criticisms

There were numerous criticisms of the science used and the conclusions arrived at in the 2010 NCSLRAR. Some of these criticisms were addressed through an addendum released by the Science Panel in April 2012. Some of the concerns addressed by the addendum are the use of the Duck tide gauge for projections, the use of models with acceleration, selective use of IPCC’s 4<sup>th</sup> Assessment Report, and the effect that updated models will have on future projections.

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<sup>50</sup> Ibid Pg. 10.

<sup>51</sup> Ibid Pg. 11.

<sup>52</sup> Ibid Pg. 12.

<sup>53</sup> Ibid Pg. 12.

<sup>54</sup> Ibid Pg. 11.

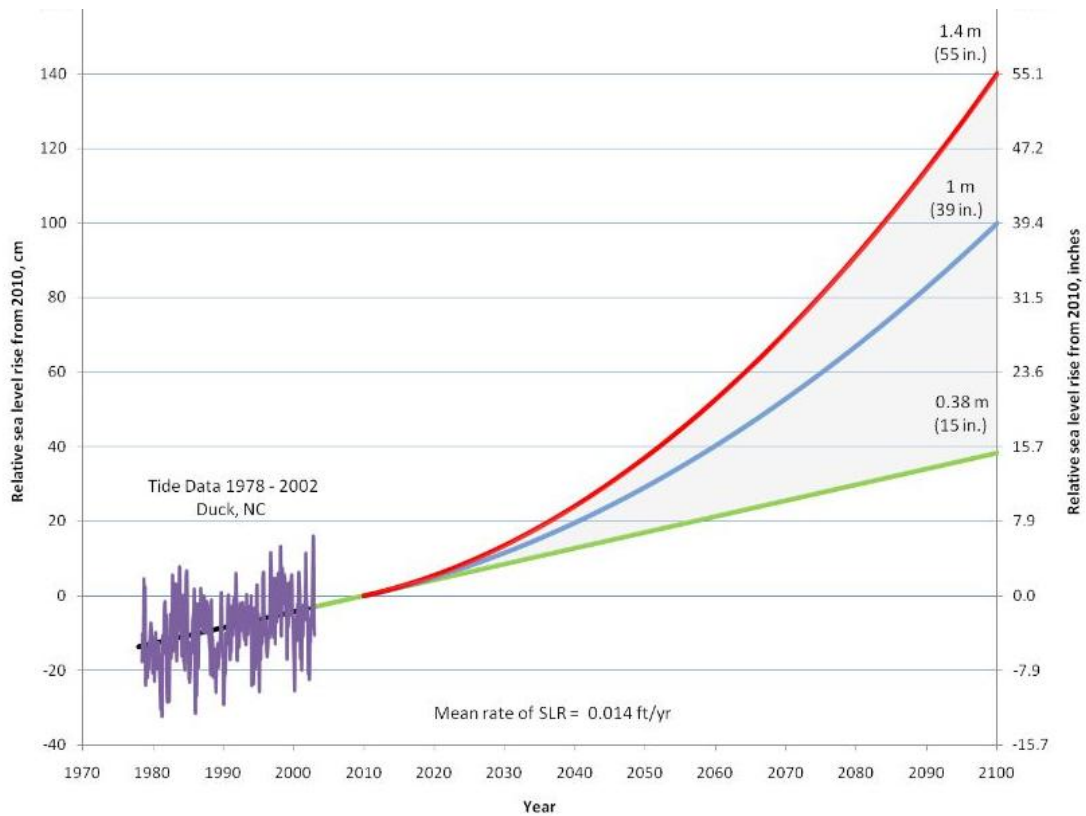


Figure 3. Magnitude of SLR for coastal North Carolina based on models using variable levels of acceleration.<sup>55</sup>

One of the strong criticisms of the 2010 NCSLRAR was the small number and relatively short time since establishment of tide gauges in North Carolina as well as the report's focus on the Duck gauge that has a comparably short history and the highest recorded mean SLR (mm SLR/year).<sup>56</sup> The Science Panel gave three reasons for using the Duck gauge: 1) it is on the open coast, 2) it is least disturbed by anthropogenic processes such as dredging of a nearby channel, and 3) its installation is well-documented and has an uninterrupted operational history. The panel deemed the other gauges compromised because they lacked one or more of the three criteria noted in the reasons for using the Duck gauge.<sup>57</sup>

<sup>55</sup> Ibid Pg. 12.

<sup>56</sup> Ibid Pg. 9.

<sup>57</sup> *Addendum to the North Carolina Sea-Level Rise Assessment Report (NCSLRAR) of 2010*. NC Coastal Resources Commission's Science Panel on Coastal Hazards. 20 Apr 2012. Pg. 1.

In regard to the use of models incorporating acceleration of SLR in the next century, the panel had numerous rationales. First of all, records longer than 125 years all support an acceleration of SLR. In addition, tide gauge records show a change in the rate of SLR when broken into decadal periods, although both acceleration and slight deceleration are found. Finally, the panel noted that even if acceleration was not found in past North Carolina geologic and tide gauge data, it did not necessarily mean that acceleration would not be seen in the next century. This is supported by the IPCC 4<sup>th</sup> Assessment Report.<sup>58</sup>

This leads to the next concern that the addendum addresses, the selective use of projections from IPCC's 4<sup>th</sup> Assessment Report. The panel chose to include IPCC's predictions for both carbon emissions and temperature because those have been found to be relatively accurate. The panel chose not to use the IPCC's SLR predictions for two reasons: the IPCC did not include melting Greenland and Antarctic ice sheet, which are now better understood and were able to be included in the NCSLRAR, and as discussed previously, the IPCC 4<sup>th</sup> Assessment Report addressed GMSL change but changes in RSL is more relevant for local planning initiatives.<sup>59</sup>

Finally, the concern of how updated scientific research would affect the results of the NCSLRAR was addressed. The panel acknowledged that there is now additional research that could change the 2010 projections, but stated that this simply reinforced their stated view that the NCSLRAR should be updated every five years.<sup>60</sup>

After reviewing the report based on the concerns expressed, the Science Panel stood by the results and recommendations found in the NCSLRAR. The Science Panel also noted in the addendum that expert panels in numerous other states, including multiple on the Atlantic coast of

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<sup>58</sup> Ibid. Pg. 2.

<sup>59</sup> Ibid. Pg. 3-4.

<sup>60</sup> Ibid. Pg. 4.



the United States, came to similar predictions for their states as the Commission's Science Panel forecasted in the NCSLRAR. The similarity of results in other states lends credence to the recommendations made.<sup>61</sup>

### **Progression of HB819**

Numerous versions of HB819, including varying levels of sea-level policy guidelines, were drafted before the final version was ratified and passed into law. Sea-level policy was not mentioned in the first two versions of the bill but appeared in Version 3 on April 7, 2011 and underwent drastic changes before the final version of HB819 became law on August 3, 2012, 16 months after its introduction.

### **Versions 3 & 4**

When sea-level policy was first introduced in HB819 it gave the Commission and NCDCM the authority for defining SLR in the state but it did not require the Commission and NCDCM do so.<sup>62</sup> Although it gave the Commission and NCDCM authority to define SLR for the state, it also gave specific instructions on what types of information could be used when defining SLR as well as instructions on how to apply it to the state's coastline.

In regard to what information can be used to define rates of SLR, this version of legislation forbade the use of scenarios including accelerated rates of SLR for extrapolation of future rates unless the rates "are from statistically significant, peer-reviewed data and are consistent with historic trends."<sup>63</sup>

These versions of HB819 also mandated that there not be a single rate of SLR defined for the entire coast, but that the coastline be broken into regions. The first requisite distinction is

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<sup>61</sup> Ibid. Pg. 5.

<sup>62</sup> "House Bill 819v3: Section 2.(b)."

<sup>63</sup> "House Bill 819v3: Section 2.(c)."

between estuarine and oceanfront shorelines. For estuarine shorelines, there are to be no fewer than two regions, one north of Cape Lookout and one south of Cape Lookout. In addition, the oceanfront shoreline is to be broken into no less than the four regions in the *North Carolina Beach and Inlet Management Plan*, released the same month. Since adequate peer-reviewed data may not be available for each region, the legislation allowed for the consideration and modification of rates from adjacent regions in the SLR rate predictions.<sup>64</sup>

#### Final version

Like the previous versions of HB819, this version states that the Commission, in conjunction with NCDCM, is the only state entity authorized to define rates of SLR for regulatory purposes.<sup>65</sup> That noted, there are considerable differences between this version and those previously proposed, including a stipulation that the Commission and NCDCM are unable to define rates of SLR prior to July 1, 2016<sup>66</sup> and a requirement for the Commission to complete an updated NCSLRAR by March 31, 2015. In addition to completing an updated NCSLRAR report, the Commission is responsible for completing an economic and environmental cost-benefit analysis of developing, or not developing, SLR regulations in the coastal region of North Carolina.<sup>67</sup>

Many of the requirements for defining a rate of SLR listed in the previous bills were incorporated into mandatory inclusions for the updated NCSLRAR. In addition to the previously discussed requirements such as not defining a single rate of SLR for the entire coastline, the Commission and its Science Panel are required to compare predictions of calculated rates of SLR based on historic data versus those made with predictive models as well as “define the

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<sup>64</sup> “House Bill 819v3: Section 2.(c).”

<sup>65</sup> “House Bill 819v6: Section 2.(a).(e).”

<sup>66</sup> “House Bill 819v6: Section 2.(b).”

<sup>67</sup> “House Bill 819v6: Section 2.(c).”

assumptions and limitations of predictive modeling used to predict future sea-level scenarios.” Also, legislature designated that the 2015 NCSLRAR should be a “comprehensive review and summary of peer-reviewed scientific literature,” including literature that predicts a decline, no change, and a rise in sea-level. This report will be available for public comment at the first regularly scheduled Commission meeting after the March 31, 2015 deadline.<sup>68</sup>

### **Passing of HB819v6**

House Bill 819 was voted on and passed in the North Carolina Senate and House of Representatives on July 2 and 3, 2012 respectively. Voting in the Senate was one-sided with a final count of 40 aye and 1 no vote while the House was more evenly spread with 68 aye and 46 no votes. The bill was ratified and sent to the then governor Bev Perdue on July 3, 2012. The bill became law on August 3, 2012 without the governor’s signature.<sup>69</sup> As a result of HB819, although SLR is undeniably occurring, North Carolina does not currently have to figure it into coastal management and development decisions.

### **Role of NC-20**

As mentioned earlier, special interest groups can play a large role in the policy making process. This was certainly the case with the group NC-20 and the passing of HB819. Part of SLR conversation since a Commission draft policy recommended planning for 39 inches of SLR, NC-20 is a strong proponent of regulation and rule making “based on science,” a basis they believe the 2010 NCSLRAR lacks. Many of the issues that NC-20 had in regard to the NCSLRAR were addressed in the addendum discussed above. Issues not addressed by the addendum include the recommendation of one rate for the entire coast, the use of predictive models without discussion of the limitations and assumptions of the model, and concerns with

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<sup>68</sup> “House Bill 819v6: Section 2.(c).”

<sup>69</sup> “House Bill 819/S.L. 2012-202.”

the economic feasibility of instituting a one-meter rate of rise, all of which are addressed in HB819 Section 2.(c).

The first issue, one rate for the entire coast, was addressed in the initial version of HB819 including SLR considerations as well as the final version. The initial version addressed this complaint by requiring that the Commission, if they chose to define a rate, define rates for various defined regions, at a minimum. In the final version of the bill, this requirement was incorporated into the necessary components for the 2015 NCSLRAR.

The next complaint of NC-20 was the Science Panel's use of predictive models instead of historic rates for their recommendation. NC-20 was uncomfortable with the use of predictive models when limitations of the models were not addressed as well as there being such a strong variability between models. This is addressed for the future through HB819 with the requirement that the 2015 NCSLRAR "define the assumptions and limitations of predictive modeling used to predict future sea-level scenarios."<sup>70</sup> Along these lines, the Science Panel did not reference any studies that did not support their assertion that the rate of sea-level rise is accelerating, although literature exists that indicates the rate is actually in a slight decline. NC-20 felt that the Science Panel's report should have addressed all potential scenarios based on the current literature, not just those that supported their view. HB819 requires that the Commission compare predictions based on historic levels to those from predictive models. The Commission has since taken this a step further, voting in May 2013 to give the Science Panel the ability to not only produce the 2015 NCSLRAR, but also a minority report if there is strong disagreement within the panel over the report. This will give the Commission the opportunity to have the most comprehensive information possible when making regulatory decisions.

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<sup>70</sup> "House Bill 819v6: Section 2.(c)."

Finally, NC-20 was concerned with the economic feasibility of defining a rate of SLR for regulatory purposes, both for the state and for coastal communities. From the state's perspective, planning for any amount of SLR will mean, at the very least, incorporating it into new public infrastructure. Take the example of a road: if SLR is factored into the planning it will have to be built higher, which not only requires more fill, but also means that the track of land required for the road will be wider to accommodate a gradual slope. Both of these elements add to the total cost of the tax-payer financed road.

In regard to coastal communities, if an area is suddenly considered to be at risk of being under water in the next 100 years or so, its property value will plummet. Not only will this affect the individual who owns the land which has lost much of its value, but if it is many properties instead of a few it will also impact the property tax revenue to the county. This tax revenue helps pay for public services such as schools. The final version of HB819 requires the Commission to look at the economic and environmental costs and benefits of both developing and not developing sea-level regulations to address this.

NC-20s primary concerns regarding the 2010 NCSLRAR were addressed in some way through the final version of HB819. This example is a testament to the power that special interest groups or collections of concerned citizens can have in effecting law and policy.

## **CHAPTER IV: WHERE CAN NORTH CAROLINA GO FROM HERE?**

Although HB819 may seem short-sighted to some, it does contain numerous provisions which call for additional study and analysis. This information will be assessed at a later date with the intention of having the best information available for decision-making.

Two portions of HB819 give rise to the hope that North Carolina's decision not to plan for sea-level rise at this time is a temporary embarrassment. House Bill 819 Section 2.(c). mandates that the Science Panel of the Commission complete a follow-up to the 2010 NCSLRAR by March 31, 2015 and that the report be presented to the General Assembly Environmental Review Commission by March 1, 2016. This section of HB819 also enumerates specific items to be included in this report that critics thought were omitted from the first report. One of the significant changes between the 2010 and 2015 NCSLRARs is that the 2015 report will consider ocean and estuarine shorelines separately. Moreover, the follow-up is required to make no fewer than four separate regional predictions (regions defined in "North Carolina Beach and Inlet Management Plan" published by NCDENR in 2011) for oceanfront shorelines, as compared to the 2010 NCSLRAR which made a single recommendation for the whole of the North Carolina coast.

In addition, the updated NCSLRAR will be able to use the most up-to-date scientific information related to emissions and GMSL because in early 2014 IPCC finalized the SLR portion of their 5<sup>th</sup> assessment report. The new report included a range of SLR projections based on different levels of emissions cuts by the end of the century that were larger than predictions in the 4<sup>th</sup> report. The higher range of projections is largely related to improvements in the modeling of melting land ice and its contribution to GMSL. The lowest prediction, 0.26-0.54 meters by 2100, is similar to estimates made in the IPCC's 4<sup>th</sup> report and is based on the supposition that

governments are able to achieve *drastic*, long-term emissions cuts by 2020. The worst case-scenario predicted in the new report is 0.52-0.98 meters by 2100, based on a scenario of continued rising emission levels.<sup>71</sup> The follow-up NCSLRAR should reinforce the findings in the 2010 report, making it more difficult for North Carolina to continue to ignore SLR in coastal planning. Also included in Section 2.(c). of HB819, is that the Commission will be conducting a study of the economic and environmental costs of developing, or not developing, SLR legislation to the NC coastal region.<sup>72</sup>

The second portion of HB819 that lends hope to a resolution is Section 2.(b) that says that the Coastal Resources Commission and the Division of Coastal Management cannot define a rate of SLR for regulatory purposes *before* July 1, 2016. Although this date is more than two years away, it can act as a built-in re-evaluation date for this policy. This date occurs shortly after the release of the 2015 NCSLRAR, meaning that the updated report will be fresh in the minds of the legislators when making further decisions.

### **Model for Rational Decision-making**

When making decisions with respect to public policy, it is important to follow some basic steps to ensure that all options are weighed and the decision-makers arrive at an informed decision. This is especially pertinent when making public policy which has the potential to affect entire populations. While these steps may not always be addressed formally, the five stages of rational decision making are:<sup>73</sup>

1. Identify the problem
2. Establish objectives
3. Use specified criteria to develop and evaluate options

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<sup>71</sup> *IPCC 5th Assessment Report: Climate Change 2013, The Physical Science Basis*. Chapter 13, Pg. 1140.

<sup>72</sup> “House Bill 819v6: Section 2.(c).”

<sup>73</sup> Orbach, M.

4. Choose an option and implement
5. Monitor and evaluate outcomes

The institutions in North Carolina followed these steps when looking into potential options for implementing or not implementing SLR legislation in previous years and will be completing them again in the years to come. The result of the initial decision-making process related to this topic was, for the time being, to not regulate at the state-level and to reevaluate after the completion of the updated NCSLRAR.

The first two stages in the decision-making process have already been addressed and are the same as they were in the initial process. Stage 1, identifying the problem, is determining whether or not to allow regulation of SLR by the state. Stage 2 is to do what is in the best interest of the state and its citizens, both economically and environmentally. The measures that the legislature and the Commission will use to determine this is the specific criteria required for the 2015 NCSLRAR. Stage 3, using specific criteria to develop and evaluate options, has not begun. As mentioned, the criteria that will be used in the decision-making process are specified by HB819 Section 2.(c). Even though these specific evaluation criteria have been identified, they have not been assessed yet and specific alternatives cannot be developed or assessed. Even though the evaluation of criteria has not been completed, one can create general options that can be tailored for evaluation when all of the information is gathered. The third, fourth, and fifth stages will be addressed after the release of the 2015 NCSLRAR with implementation being no earlier than July 1, 2016.

Addressed below are general potential paths that the state may take in regard to SLR legislation after July 1, 2016.



## Status quo

The North Carolina legislature is in no way required to mandate or even allow the development of SLR policy for the state. As mentioned before, HB819 has a logical re-evaluation date of July 1, 2016. However, this re-evaluation does not mean that the legislation will choose to allow the development of SLR policy by the Commission.

Arguments can be made for and against state-level regulation of SLR in North Carolina. In support of non-statewide regulation is that HB819 has a section which states that it will not “prohibit a county, municipality, or other local government entity from defining rates of sea-level change for regulatory purposes.”<sup>74</sup> A continuation of the status quo would indicate that individual cities or counties along the coast will be able to create their own SLR policy based on their specific needs in the future.\* This is an especially potent argument when factoring in the wide range of SLR observed at various tidal gauges along the coast.

An argument for SLR policy being instituted at the state level is that smaller cities and counties along the coast may not have the resources necessary to implement policies on their own. The 2015 NCSLRAR will include regional recommendations which will aid individual towns or counties in setting a level of rise for planning purposes if they choose to implement policies. However, as noted in a 2013 study, some communities have regulations that would make the implementation of SLR policy difficult. An example of this is historic preservation guidelines that prohibit modifications to historic structure. An interview conducted for the same study also brought up questions of social equality in regard to execution of SLR policy in the state. The interviewee noted that if people believe that waterfront and low-lying properties will

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\*This ability would be greatly hindered if a provision similar to HB74 Section 10.2(a), which temporarily limits the ability of cities and counties to pass ordinances more strict than the state’s without a unanimous vote, was instituted permanently.

<sup>74</sup> “House Bill 819v6: Section 2.(a).(c).”

be underwater in the coming years, property values will drop drastically, causing disproportionate harm to the poorest people living near the coast,<sup>75</sup> especially in counties that are already struggling economically like Tyrell County. Figure 2 shows the drastic land loss that is predicted for all levels of SLR in Tyrell County. From 2007 to 2011, the US Census Bureau reported Tyrell County had a median household income approximately 25% below the state's average and recorded a 20.5% poverty rate.<sup>76</sup>

Also in support of non-regulation at the state level is that while North Carolina does not have official regulations regarding SLR, there are coastal management regulations that inadvertently capture SLR, such as the state's coastal setback regulations. North Carolina uses erosion setbacks for coastal development. This means that the distance that a building is required to be from the measurement line is determined using mean erosion rates. An example of this is that a structure less than 5,000 square feet must have a setback of 30 times the erosion rate or 60 feet, whichever is larger. Structures are grouped into different setback requirements based on size with larger structures having larger setback requirements.<sup>77</sup> Approximately every five years NCDCM completes a comprehensive assessment of erosion rates along the North Carolina coast. This assessment uses aerial photography, compares the current shoreline to a baseline, and calculates erosion rates using a computer program.<sup>78</sup> Since the study measures the change in the shoreline over time it should account for changes resulting from SLR as well as those from erosion. In this way, the state is already accounting for current SLR in new coastal development. However, since the rate of shoreline change from the combined effects of erosion and SLR will

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<sup>75</sup> Donargo, A., K. Ducklow, N. Morison. "Cultural perceptions of climate change and sea level rise adaptation strategies in Maryland, North Carolina, and the Baltic Sea Coast." Duke University Masters Project. 2013. Pg. 52.

<sup>76</sup> Ibid Pg. 24.

<sup>77</sup> NCAC 07H .0306(a)

<sup>78</sup> "Coastal Hazard & Storm Information: What You Should Know About Erosion and Oceanfront Development." Accessed 30 Mar 2014.

increase based on current projections, simply using current erosion rates to calculate setback requirements may not be sufficient in determining where construction should be allowed in relation to the shoreline.

### **Allow Definition of Rate of SLR**

When it comes time for the North Carolina General Assembly to once again decide whether to allow for the definition of SLR for regulatory purposes, they will have both the IPCC 5<sup>th</sup> Assessment Report as well as the 2015 NCSLRAR from which to draw information. If the legislature decides to allow a rate of SLR to be defined for regulatory purposes it will likely continue to delegate authority to the Commission, working in conjunction with NCDCM, to do so. At this time, the Commission's Science Panel on Coastal Hazards will have completed the 2015 NCSLRAR and the Commission will have the opportunity to follow the recommendations laid out in the updated report. From here, the Commission will have two potential paths to take: requiring that public and private infrastructure in the coastal region plan for a benchmark of SLR or assisting local governments in making their own decisions regarding SLR planning in their community. Both of these alternatives are seen through the progression of a draft SLR policy that was first introduced to the Commission in October 2010 and released for public comment in August 2012.

#### **Initial policy draft: October 2010**

The first draft policy proposed to the Commission in 2010 had a stated goal of “establishing a framework for improved understanding of the potential impacts of sea-level rise, and for supporting planned adaptation and resilience to rising sea levels.”<sup>79</sup> This draft followed the recommendations of the 2010 NCSLRAR and adopted a planning benchmark of one meter of

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<sup>79</sup> 15A NCAC 07M .1301 Declaration of General Policy. Draft – February 25, 2011.

rise for the state. It did recognize that North Carolina is experiencing regional differences in SLR and reserved the right to initiate regional benchmarks that are different from the more general one meter state standard. This draft includes language that would require new public and private infrastructure in the coastal region be built to accommodate the SLR benchmark and recognizes the responsibility of the Commission to assist local communities with their planning. Finally, the draft states that the Commission will regularly review their procedures in regard to matters such as development permits to ensure that effects of SLR are accounted for in their rulings.<sup>80</sup>

#### Policy draft released for public comment: August 2012

The 2012 draft policy has the same stated goal of as the 2010 draft of improving understanding and support for adaptation planning.<sup>81</sup> The “Policy Statements” section includes goals of the Commission and NCDRCM such as promoting public education of SLR impacts, providing updated scientific information to the 20 coastal counties, and assisting local governments with land-use planning guidance and support. This draft of the policy does not identify a specific benchmark for SLR planning for the state but simply recognizes that it is not uniform across the state and recommends communities take into account regional trends in SLR. In addition, in this draft the Commission does not require but encourages coastal areas to consider SLR into their development and planning.<sup>82</sup>

#### How will the Commission proceed?

Both the initial draft and the product released for public comment have a strong focus on education at the local community level and the recognition of regional differences in SLR as well as relaying the Commission’s intent to provide communities with the best scientific information

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<sup>80</sup> Ibid

<sup>81</sup> 15A NCAC 07M .1301 Declaration of General Policy. Draft CRC Sea-Level Rise Policy – August 15, 2012.

<sup>82</sup> Ibid

available for their decisions. The version released for public comment, a softer policy than the original with all language of planning benchmarks and requirements for new development to accommodate SLR removed, is the best indication available of the direction that the Commission will likely proceed if allowed to define a rate of SLR for regulatory purposes. Based on the language and recommendations found in the 2012 draft policy as well as an interview with a NCDCM staff member, it is unlikely that given the chance to define a rate of SLR the Commission will look to change their statewide rules and regulations but instead will take an advisory and supportive role for local governments in their planning initiatives.

Clearly the newly appointed Commission could stray from the previous Commission's policy statement, but conversations with NCDCM staff and a current Commission member leads to the belief that the August 2012 policy is the likely path the current Commission will take if allowed. It is important to note that the Commission is not required to follow the recommendations of the Science Panel but can choose to either not define a rate of SLR or can define a rate other than that recommended by the panel.

Although indications are that the Commission intends their "Policy Statement" to be used as a guideline for coastal communities, if a rate of SLR is defined for regulation it gives other state agencies the opportunity to use the regulation in their policies, possibly not as guidelines like the Commission. An example of where this could happen is with modifications to stormwater regulations, possibly regarding structural requirements, which the Commission does not manage. This may be an important consideration for the Commission when making a decision on whether to define a rate of SLR.

## CHAPTER V: INFORMING FUTURE POLICY

One of the strong arguments against SLR policy development is the great number of variables involved and that SLR prediction is an inexact science. Disagreement among scientists and other knowledgeable stakeholders about how much SLR to expect and plan for in coastal communities will continue, but everyone should agree that future decision-making should be as informed as possible. Current initiatives at both the state and national levels have the purpose of informing sea-level science and prediction in the future and are relevant to future SLR predictions in North Carolina.

### State Level: North Carolina

Currently the best basis for RSL predictions is historic sea-level (geologic evidence) and long-term tidal observations (tide gauges).

The 2010 NCSLRAR recommends continued maintenance of long-term tide gauges (Figure 4) as well as adding new monitoring stations along the coast,<sup>83</sup> which is an important first step in any plan to improve the effectiveness and

reliability of predictive models. These monitoring stations provide further proof that sea-level in North Carolina is indeed rising, hopefully alleviating some of the doubts raised in response to the

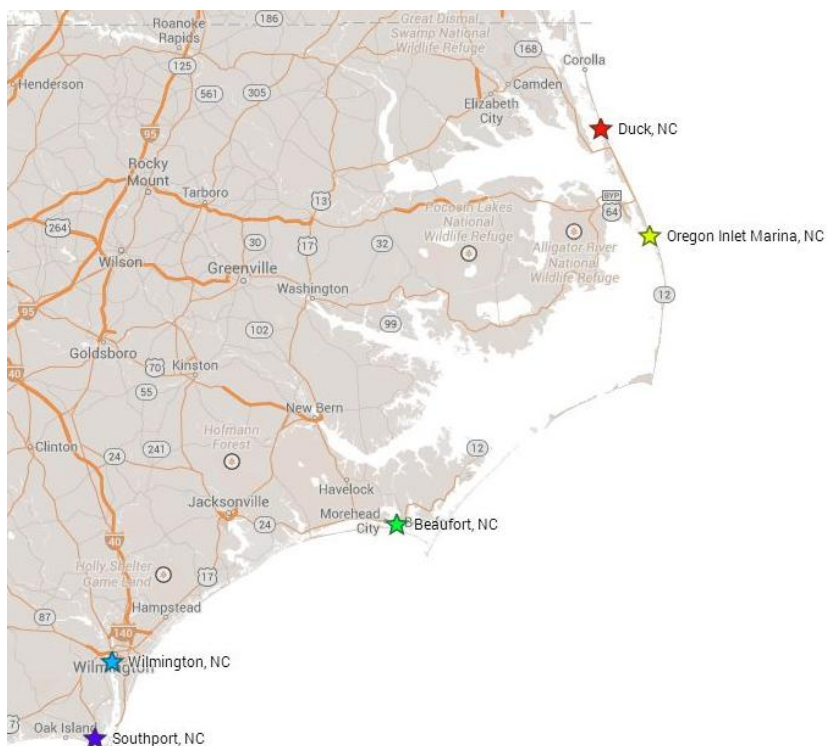


Figure 4. Locations of the five active tide gauges in North Carolina.

<sup>83</sup> North Carolina Sea-Level Rise Assessment Report. Pg. 12-13.

2010 NCSLRAR. Increasing the number of monitoring stations on the North Carolina coast would also allow for more accurate region specific SLR predictions since it has been observed through tide gauge history that SLR in North Carolina is quite variable along the length of the coast.<sup>84</sup> It is important to note that this solution will not be truly effective for many years to come when the tide gauges have been able to amass enough data to be used for predictions.

As discussed previously, there are many effects of SLR other than what is measured by tide gauges. Some of these effects – saltwater intrusion, raised water tables, changes in vegetation, habitat shifts, and increased erosion rates – can be observed and measured over time. Researchers are already looking at some of these consequences and these are all factors that can be assessed in the future with the intent to better quantify the effects of SLR on the North Carolina coastal region.

## **National Level**

Although effective SLR legislation has to originate with state and local governments, the United States is beginning to institute measures that will aid in informed decision-making. An example of this is NOAA's Sentinel Site Program in which North Carolina is included. The Sentinel Site Program builds on the fact that NOAA has a variety of assets on the coast of the US (i.e., sanctuaries, estuarine reserves, marine protected areas, coastal monitoring and data collection tools) that can be helpful in protecting natural resources, measuring tides, and establishing true water height measurements. The goal of the Sentinel Site Program is not simply to amass data, but to bring together stakeholders from various backgrounds with interest in a particular region, such as federal, state, and local officials and local university researchers. The

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<sup>84</sup> Ibid Pg. 9.

hope is that this program will foster a cooperative environment where real solutions to coastal management issues related to climate change, such as shoreline protection, can be developed.<sup>85</sup>

The Sentinel Site Program began in 2011 with the choice of five inaugural cooperative sites in various US regions, including a site at the Rachel Carson Preserve in Beaufort, North Carolina. This location is a good choice because it represents average conditions for coastal North Carolina as well as having a high concentration of marine science facilities including NOAA, Duke University Marine Lab, University of North Carolina Institute of Marine Science, North Carolina State University Center for Marine Sciences and Technology, and NCDRCM. The first focus of this initiative is to quantify the impacts of climate change on coastal communities, specifically SLR and inundation.<sup>86</sup>

Intended future development of this project includes expansion to the entire North Carolina coast because of its variety of coastal habitat types and resulting gradient of SLR vulnerability.<sup>87</sup> Also, the importance of coastal-related industries such as fishing and tourism and the vulnerability of these industries to the effects of SLR lead NOAA to believe that lessons learned from the North Carolina Sentinel Site will be applicable to areas with similar economies.

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<sup>85</sup> “NOAA Sentinel Site Program.”

<sup>86</sup> Ibid

<sup>87</sup> “North Carolina Sentinel Site Cooperative.”



## CHAPTER VI: CONCLUSION

Based on the IPCC's 4<sup>th</sup> and 5<sup>th</sup> Assessment Reports, SLR is undoubtedly occurring on a global scale. However, predicting sea-level rise on a local or regional scale is a daunting task with many associated uncertainties. For this reason, all predicted levels of rise will likely meet with contention for years to come. The only way to combat the uncertainty related to SLR predictions is increased data collection and monitoring, such as increasing the numbers and reliability of tide gauges and NOAA's Sentinel Site Program and continued refinement in the models that address the question of probably future conditions.

North Carolina legislators will have copious amounts of information to draw from for their next decision regarding SLR definition, including the IPCC's newly released 5<sup>th</sup> Assessment Report and the 2015 follow-up NCSLRAR. In addition, since HB819 caused North Carolina to be ridiculed at both the national and international level, the legislature will have to consider what their next decision will reveal to the rest of the country and world about North Carolina.

Uncertainty related to the *amount* of SLR to expect is no excuse for North Carolina to disallow planning for any rise. Many other states, including Maine and Delaware on the Atlantic coast, are establishing plans to deal with various SLR scenarios by 2100. At a minimum, starting July 1, 2016, North Carolina legislators need to allow for planning of rates of SLR based on historical data. A better outcome would be to take a moderately precautionary approach and plan for SLR with *some* acceleration as proposed in the 2010 NCSLRAR and that will likely be corroborated in the 2015 follow-up.

Finally, we must insist that the 2015 NCSLRAR be given more credence than its predecessor in SLR legislative decisions, and that the recommendations of that report be strongly and seriously considered. There is little reason to spend taxpayer dollars to secure recommendations from experts in the field if those recommendations are summarily dismissed.